

Notice of Allowability**Application No.**

10/688,267

Examiner

AKLILU k. WOLDEMARIAM

Applicant(s)

REEVES ET AL.

Art Unit

2624

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 08/21/2008.
2. ☒ The allowed claim(s) is/are 28-38, 42-62, 66-86 and 90-99 (now remember 1-63 for issue).
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some* c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
(a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
(b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date 11/17/2003
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413),
Paper No./Mail Date 20080908
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.
2. Authorization for this examiner's amendment was given in a telephone interview with Mr. Rod S. Turner on 08/21/2008.
3. The application has been amended as follows:

Applicants withdraw claims 1-27 and elected claims 28-99 without traverse during phone interview on 08/20/2008.

Claims 1-27, 39-41, 63-65 and 87-89 have been cancelled.

In claim 28, please replace the subject matter in the claim as follows:

28. A method for correlating a segmentation of 3-d images of a pulmonary nodule from a high-resolution computed tomography (CT) scans, the images being in a floating point pixel-format associated with a 6-dimensional parameter space and including a first image (im_1) obtained at time-1 and a second image (im_2) obtained at time-2, the method comprising the steps of:

- (a) selecting a first region-of-interest (ROI_1) for the nodule in the first image (im_1);
- (b) selecting a second region-of-interest (ROI_2) for the nodule in the second image (im_2);
- (c) registering the second region-of-interest (ROI_2) to the first region-of-interest (ROI_1) to obtain a transformed second region-of-interest (ROI_{2t});

(d) separately segmenting both the nodule in the first region-of-interest (ROI_1) and the transformed second region-of-interest (ROI_{2t}); and

(e) adjusting the first segmented nodule (S_1) and the second segmented nodule (S_2), registering the second region-of-interest (ROI_2) to the first region-of-interest (ROI_1) to obtain a transformed second region-of-interest (ROI_{2t}) comprising the substeps of:

calculating initial rigid-body transformation parameters for a rigid-body transformation on the second region-of-interest (ROI_2);

determining the optimum rigid-body transformation parameters by calculating a registration metric between the first region-of-interest (ROI_1) and the rigid-body transformation on the second region-of-interest (ROI_2); and

generating a registered image from the optimum rigid-body transformation parameters, the registration metric being calculated by:

transforming the second region-of-interest (ROI_2) with the initial rigid-body transformation parameters to obtain a transformed second region-of-interest (ROI_{2t});

calculating the registration metric as a mean-squared-difference (MSD) between the transformed second region-of-interest (ROI_{2t}) and the first region-of-interest (ROI_1); and

searching for the minimum mean-squared-difference (MSD) in the 6-dimensional parameter space, the transforming of the second region-of-interest (ROI_2) to obtain the transformed second region-of-interest (ROI_{2t}) is a mapping of a point v in 3-d space to a point v' in transformed space defined by:

$$v' = R_x R_y R_z v + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix}$$

wherein R_x , R_y , and R_z are rotation matrices defined as:

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(r_x) & -\sin(r_x) \\ 0 & \sin(r_x) & \cos(r_x) \end{bmatrix}$$
$$R_y = \begin{bmatrix} \cos(r_y) & 0 & \sin(r_y) \\ 0 & 1 & 0 \\ -\sin(r_y) & 0 & \cos(r_y) \end{bmatrix}$$
$$R_z = \begin{bmatrix} \cos(r_z) & -\sin(r_z) & 0 \\ \sin(r_z) & \cos(r_z) & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

In claim 42, delete -39- and insert -28-.

In claim 43, delete -40- and insert -28-.

In claim 52, please replace the subject matter in the claim the following:

52. A registration apparatus for correlating a segmentation of 3-d images of a pulmonary nodule from a high-resolution computed tomography (CT) scans, the images being in a floating point pixel-format associated with a 6-dimensional parameter space and including a first image (im_1) obtained at time-1 and a second image (im_2) obtained at time-2, the registration apparatus comprising:

a registration unit configured to:

- (a) select a first region-of-interest (ROI_1) for the nodule in the first image (im_1);
- (b) select a second region-of-interest (ROI_2) for the nodule in the second image (im_2);
- (c) register the second region-of-interest (ROI_2) to the first region-of-interest (ROI_1) to obtain a transformed second region-of-interest (ROI_{2a});

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(d) separately segment both the nodule in the first region-of-interest (ROI_1) and the transformed second region-of-interest (ROI_{2t}); and

(e) adjust the first segmented nodule (S_1) and the second segmented nodule (S_2);

said registration unit being configured to:

calculate initial rigid-body transformation parameters for a rigid-body transformation on the second region-of-interest (ROI_2);

determine the optimum rigid-body transformation parameters by calculating a registration metric between the first region-of-interest (ROI_1) and the rigid-body transformation on the second region-of-interest (ROI_2); and

generate a registered image from the optimum rigid-body transformation parameters, the registration metric is calculated by:

transforming the second region-of-interest (ROI_2) with the initial rigid-body transformation parameters to obtain a transformed second region-of-interest (ROI_{2t});

calculating the registration metric as a mean-squared-difference (MSD) between the transformed second region-of-interest (ROI_{2t}) and the first region-of-interest (ROI_1); and

searching for the minimum mean-squared-difference (MSD) in the 6-dimensional parameter space, the transforming of the second region-of-interest (ROI_2) to obtain the transformed second region-of-interest (ROI_{2t}) being a mapping of a point v in 3-d space to a point v' in transformed space defined by:

$$v' = R_x R_y R_z v + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix}$$

wherein R_x , R_y , and R_z are rotation matrices defined as:

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(r_x) & -\sin(r_x) \\ 0 & \sin(r_x) & \cos(r_x) \end{bmatrix}$$
$$R_y = \begin{bmatrix} \cos(r_y) & 0 & \sin(r_y) \\ 0 & 1 & 0 \\ -\sin(r_y) & 0 & \cos(r_y) \end{bmatrix}$$
$$R_z = \begin{bmatrix} \cos(r_z) & -\sin(r_z) & 0 \\ \sin(r_z) & \cos(r_z) & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

In claim 66, delete -63- and insert -52-.

In claim 67, delete -64- and insert -52-.

In claim 76, please replace the subject matter in the claim the following:

76. An article of manufacture for correlating a segmentation of 3-d images of a pulmonary nodule from a high-resolution computed tomography (CT) scans, the images being in a floating point pixel-format associated with a 6-dimensional parameter space and including a first image (im_1) obtained at time-1 and a second image (im_2) obtained at time-2, the article comprising:

a machine readable medium containing one or more programs which when executed implement the steps of:

- (a) selecting a first region-of-interest (ROI_1) for the nodule in the first image (im_1);
- (b) selecting a second region-of-interest (ROI_2) for the nodule in the second image (im_2);
- (c) registering the second region-of-interest (ROI_2) to the first region-of-interest (ROI_1) to obtain a transformed second region-of-interest (ROI_{2t});

(d) separately segmenting both the nodule in the first region-of-interest (ROI_1) and the transformed second region-of-interest (ROI_{2t}); and

(e) adjusting the first segmented nodule (S_1) and the second segmented nodule (S_2), registering the second region-of-interest (ROI_2) to the first region-of-interest (ROI_1) to obtain a transformed second region-of-interest (ROI_{2t}) comprising the substeps of:

calculating initial rigid-body transformation parameters for a rigid-body transformation on the second region-of-interest (ROI_2);

determining the optimum rigid-body transformation parameters by calculating a registration metric between the first region-of-interest (ROI_1) and the rigid-body transformation on the second region-of-interest (ROI_2); and

generating a registered image from the optimum rigid-body transformation parameters, the registration metric being calculated by:

transforming the second region-of-interest (ROI_2) with the initial rigid-body transformation parameters to obtain a transformed second region-of-interest (ROI_{2t});

calculating the registration metric as a mean-squared-difference (MSD) between the transformed second region-of-interest (ROI_{2t}) and the first region-of-interest (ROI_1); and

searching for the minimum mean-squared-difference (MSD) in the 6-dimensional parameter space, the transforming of the second region-of-interest (ROI_2) to obtain the transformed second region-of-interest (ROI_{2t}) being a mapping of a point v in 3-d space to a point v' in transformed space defined by :

$$v' = R_x R_y R_z v + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix}$$

wherein R_x , R_y , and R_z are rotation matrices defined as:

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(r_x) & -\sin(r_x) \\ 0 & \sin(r_x) & \cos(r_x) \end{bmatrix}$$
$$R_y = \begin{bmatrix} \cos(r_y) & 0 & \sin(r_y) \\ 0 & 1 & 0 \\ -\sin(r_y) & 0 & \cos(r_y) \end{bmatrix}$$
$$R_z = \begin{bmatrix} \cos(r_z) & -\sin(r_z) & 0 \\ \sin(r_z) & \cos(r_z) & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

In claim 90, delete -89- and insert -76-.

In claim 91, delete -88- and insert -76-.

REASONS FOR ALLOWANCE

3. Claims 28-38, 42-62, 66-86 and 90-99 are allowed over the prior art of record.
4. The following is an examiner's statement of reasons for allowance: In addition to the teachings of claims 28, 52 and 76, as a whole, closest art of record failed to teach or suggest among other thing,

"calculating initial rigid-body transformation parameters for a rigid-body transformation on the second region-of-interest (ROI₂);

determining the optimum rigid-body transformation parameters by calculating a registration metric between the first region-of-interest (ROI₁) and the rigid-body transformation on the second region-of-interest (ROI₂); and

generating a registered image from the optimum rigid-body transformation parameters, the registration metric being calculated by:

transforming the second region-of-interest (ROI₂) with the initial rigid-body transformation parameters to obtain a transformed second region-of-interest (ROI_{2t});

calculating the registration metric as a mean-squared-difference (MSD) between the transformed second region-of-interest (ROI_{2t}) and the first region-of-interest (ROI₁); and

searching for the minimum mean-squared-difference (MSD) in the 6-dimensional parameter space, the transforming of the second region-of-interest (ROI₂) to obtain the transformed second region-of-interest (ROI_{2t}) is a mapping of a point v in 3-d space to a point v' in transformed space defined by:

$$v' = R_x R_y R_z v + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix}$$

wherein R_x , R_y , and R_z are rotation matrices defined as:

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(r_x) & -\sin(r_x) \\ 0 & \sin(r_x) & \cos(r_x) \end{bmatrix}$$

$$R_y = \begin{bmatrix} \cos(r_y) & 0 & \sin(r_y) \\ 0 & 1 & 0 \\ -\sin(r_y) & 0 & \cos(r_y) \end{bmatrix}$$

$$R_z = \begin{bmatrix} \cos(r_z) & -\sin(r_z) & 0 \\ \sin(r_z) & \cos(r_z) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to AKLILU K. WOLDEMARIAM whose telephone number is (571)270-3247. The examiner can normally be reached on Monday-Thursday 6:30 a.m.-5:00 p.m EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on 571-272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Samir Ahmed,

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Examiner, Art Unit 2624
08/23/2008

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